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Lockwood et al.

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[54] **FASTENER ASSEMBLY FOR ESTABLISHING A MECHANICAL AND ELECTRICAL CONNECTION TO COATED METAL**

[75] Inventors: **Mark D. Lockwood**; **Mark J. Friederick**, both of Dubuque, Iowa

[73] Assignee: **Barnstead/Thermolyne**, Dubuque, Iowa

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[51] **Int. Cl.**[6] **H01B 17/00**

[52] **U.S. Cl.** ..... **174/138 R**; 411/155

[58] **Field of Search** ..... 174/88 B, 99 R, 174/137 R, 138 R; 411/155, 156

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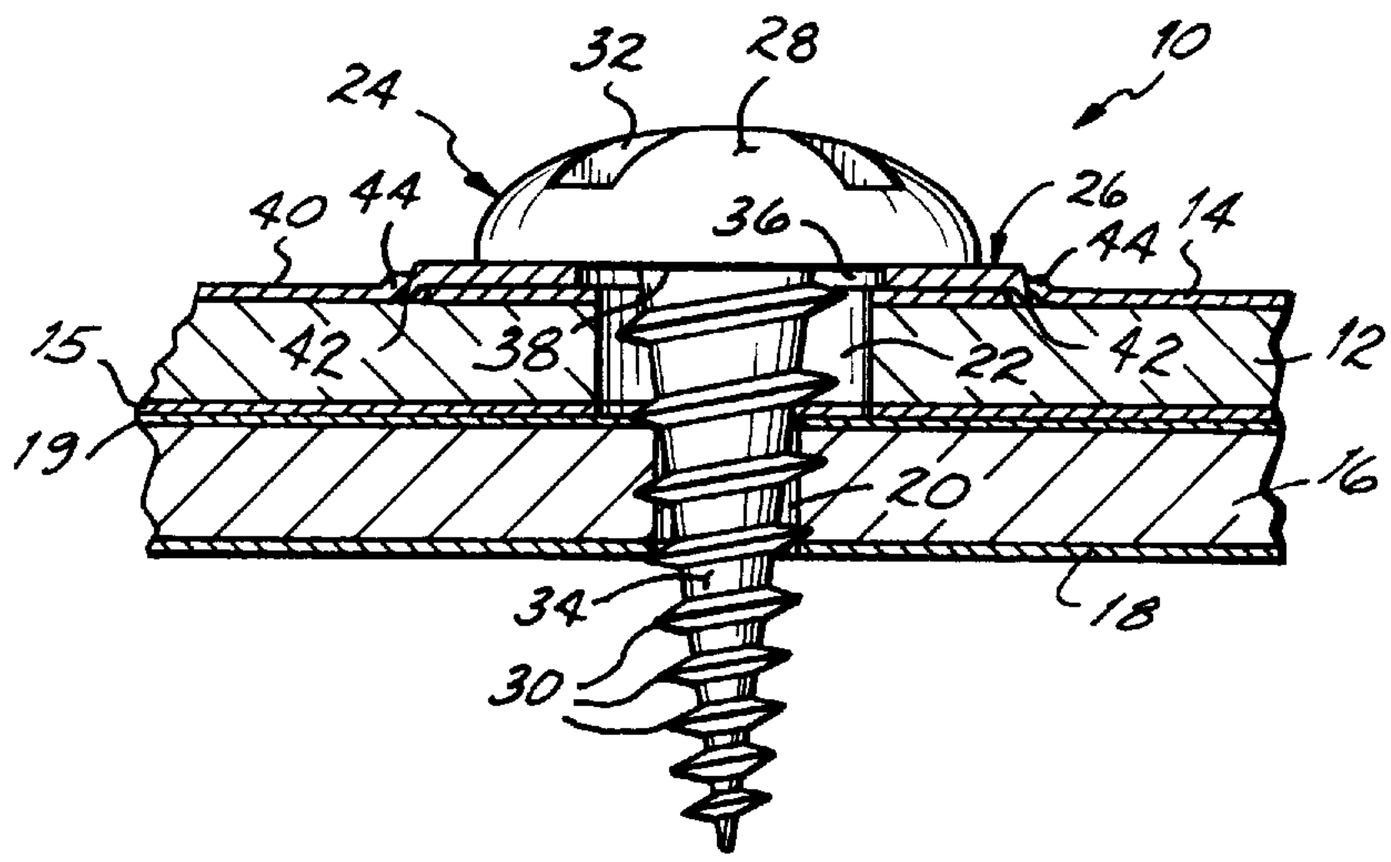
Primary Examiner—Kristine L. Kincaid
Assistant Examiner—Dhiru R. Patel
Attorney, Agent, or Firm—Wood, Herron & Evans, L.L.P.

[57] **ABSTRACT**

An electrically operated device and fastener assembly for establishing an electrical and mechanical connection on the device. The fastener assembly generally includes a fastener and a washer which may be permanently flattened against the device to establish an electrical connection to a piece of coated metal. Upon removal of the fastener, the washer remains permanently flattened against the device or piece of metal and mechanically connected thereto by a build-up of coating material on projections associated with the washer. Fastener assemblies may be constructed using, for example, sheet metal screws requiring only one of the washers in the assembly or machine screws which may require two of the washers.

11 Claims, 3 Drawing Sheets



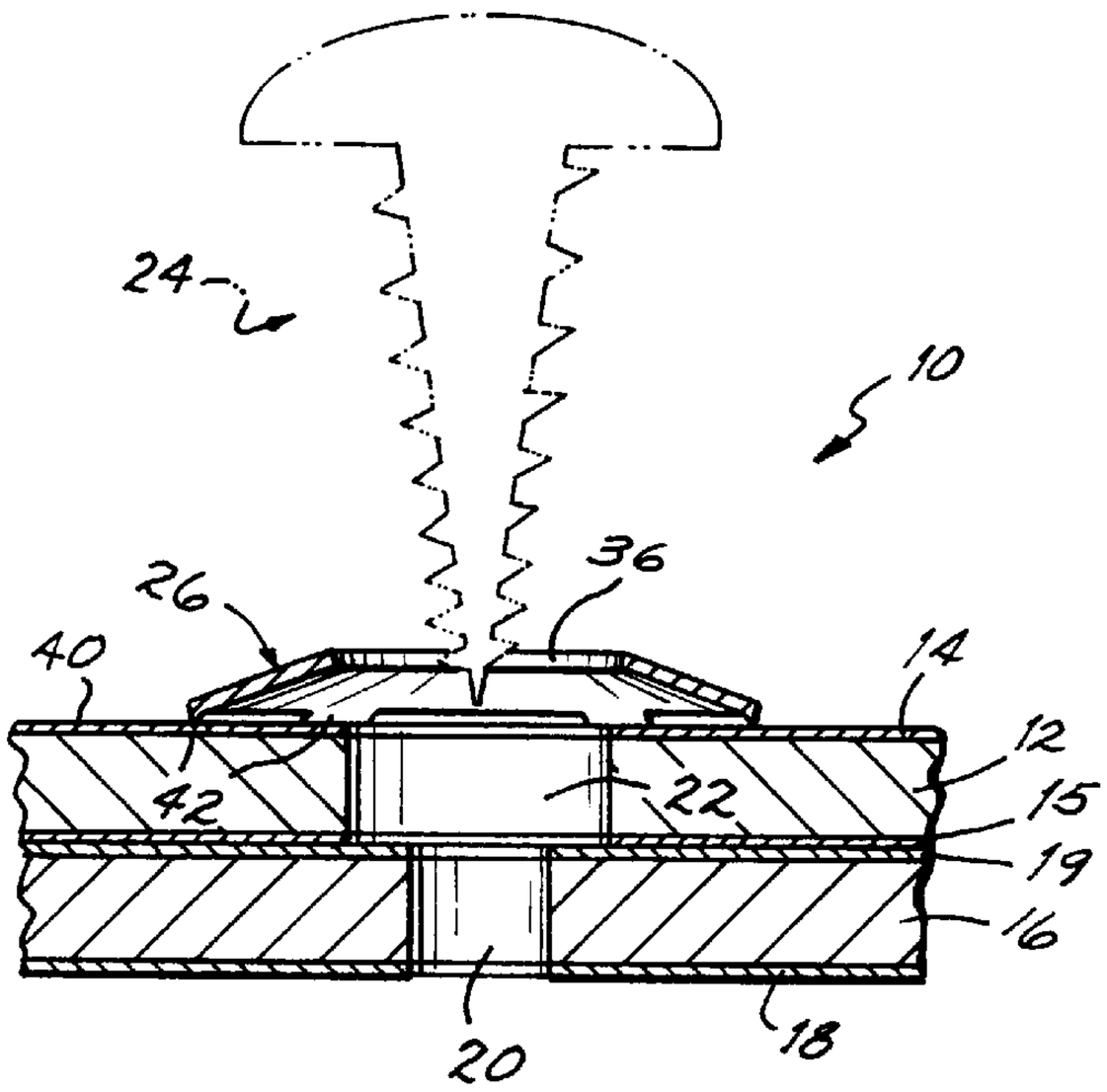


FIG. 1

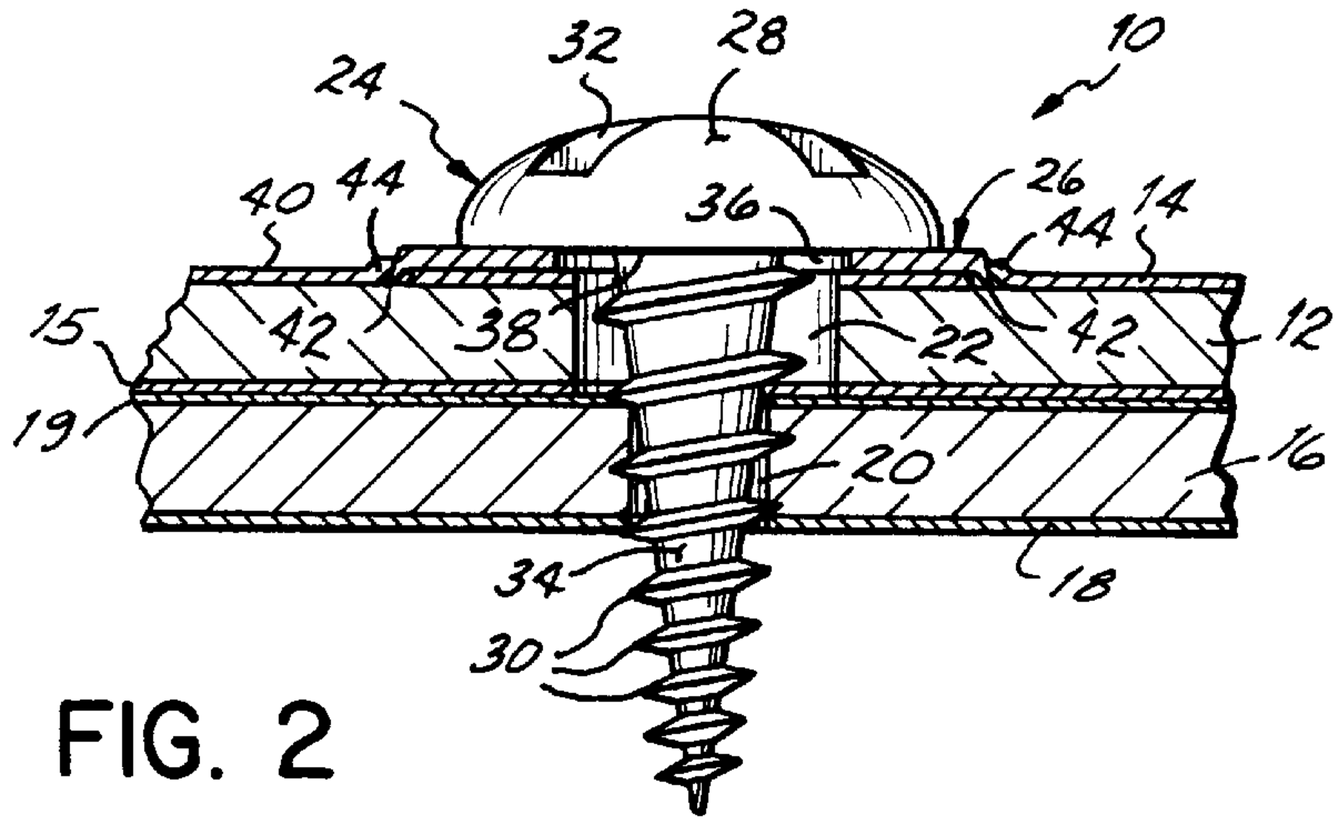


FIG. 2

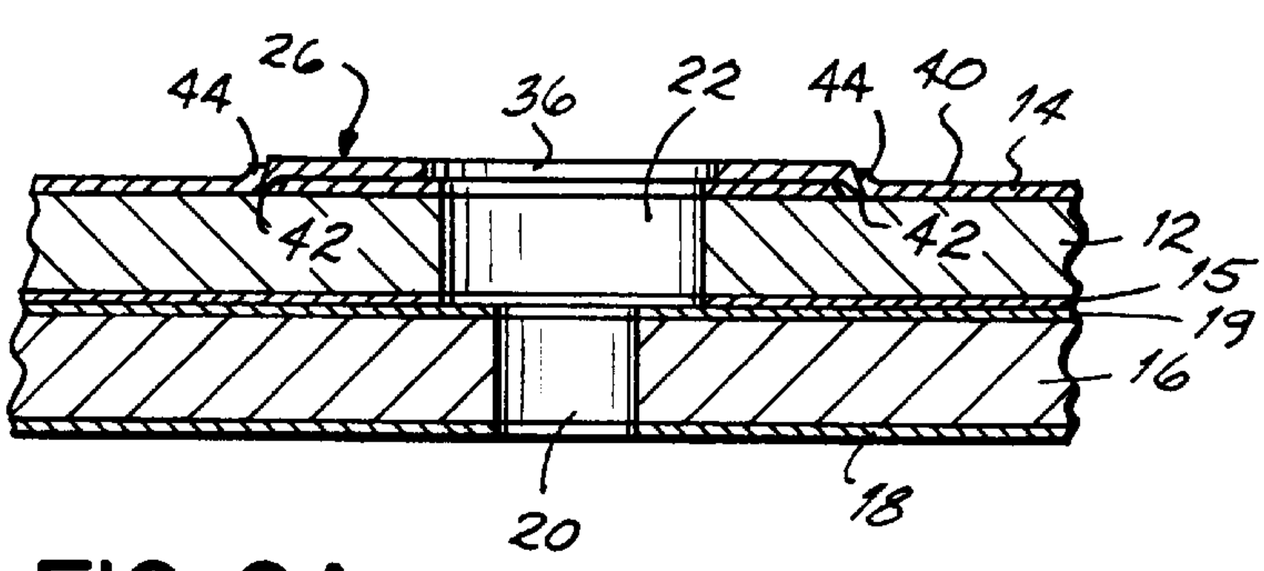


FIG. 2A

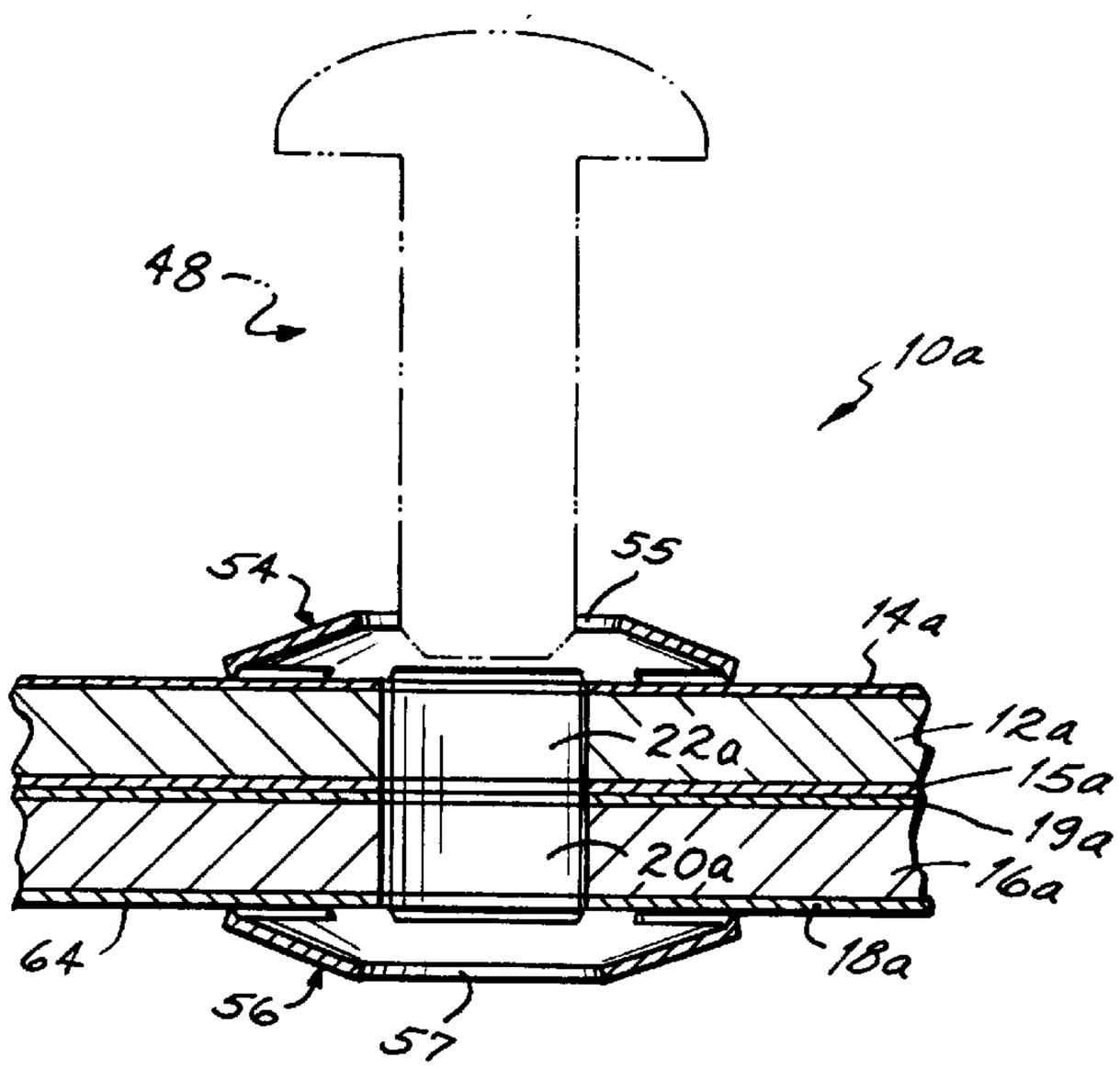


FIG. 3

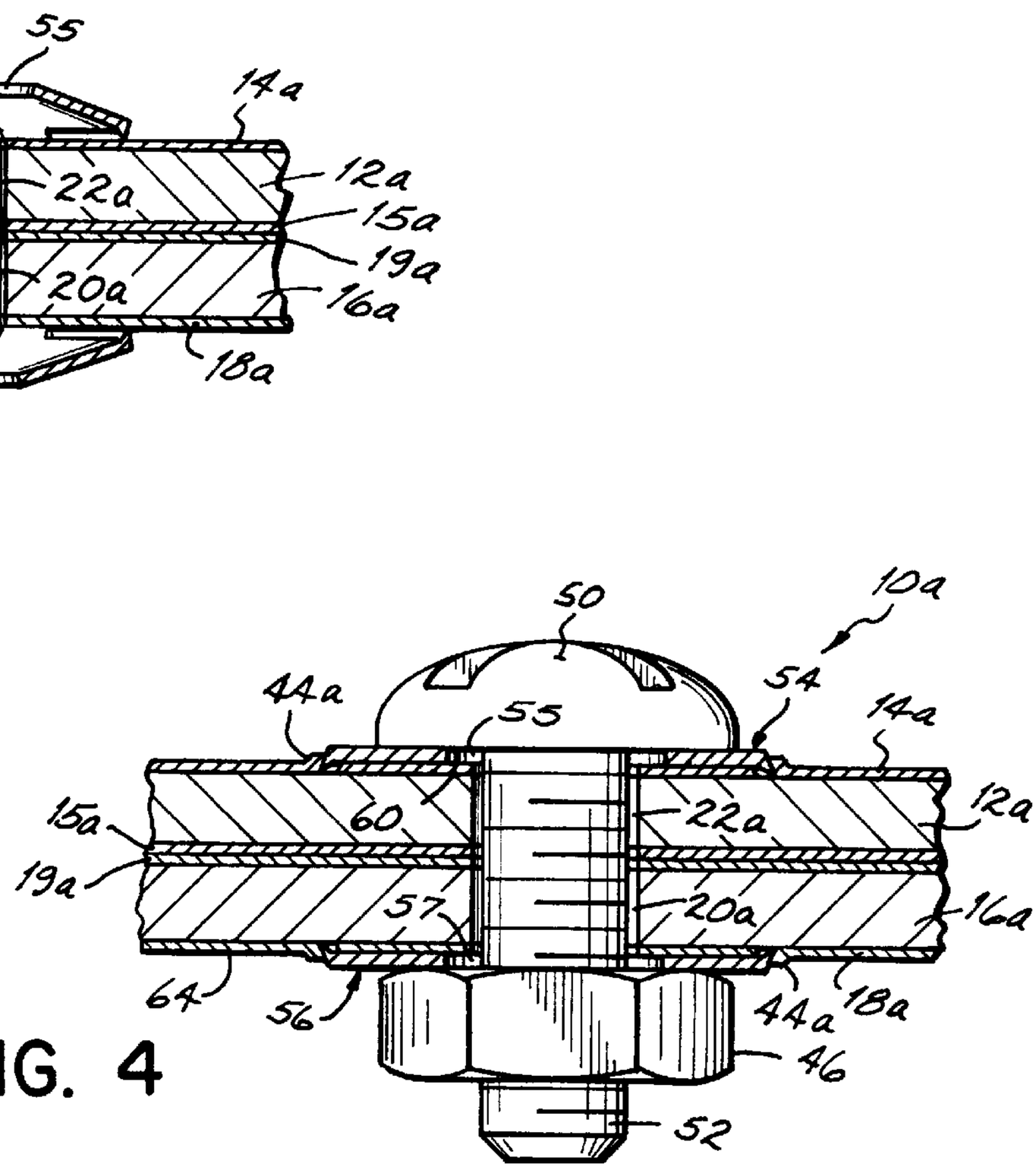


FIG. 4

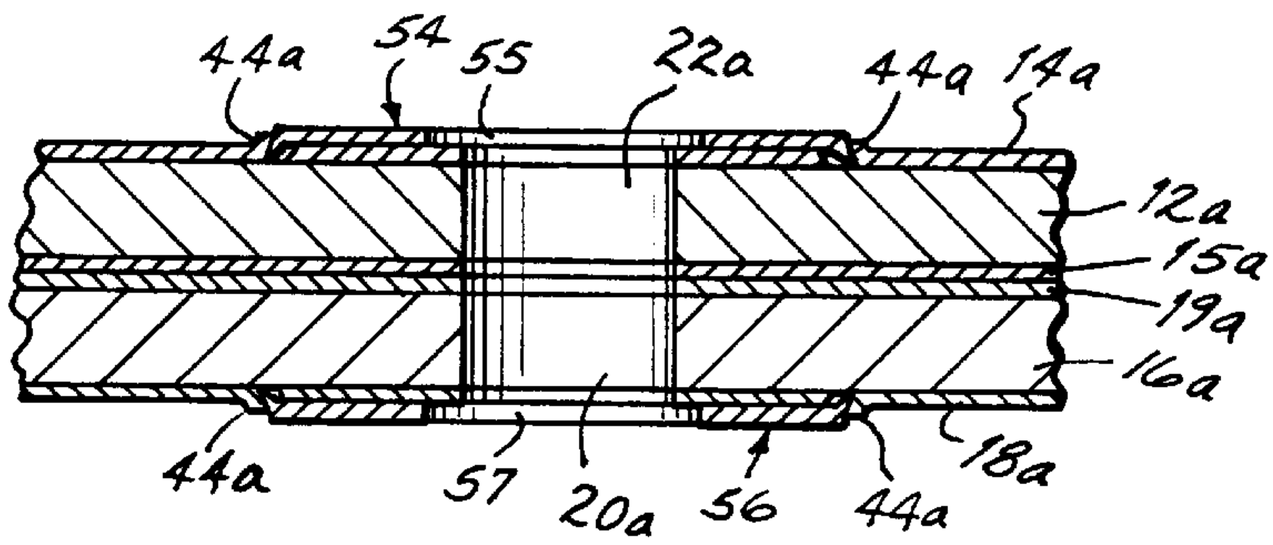


FIG. 4A

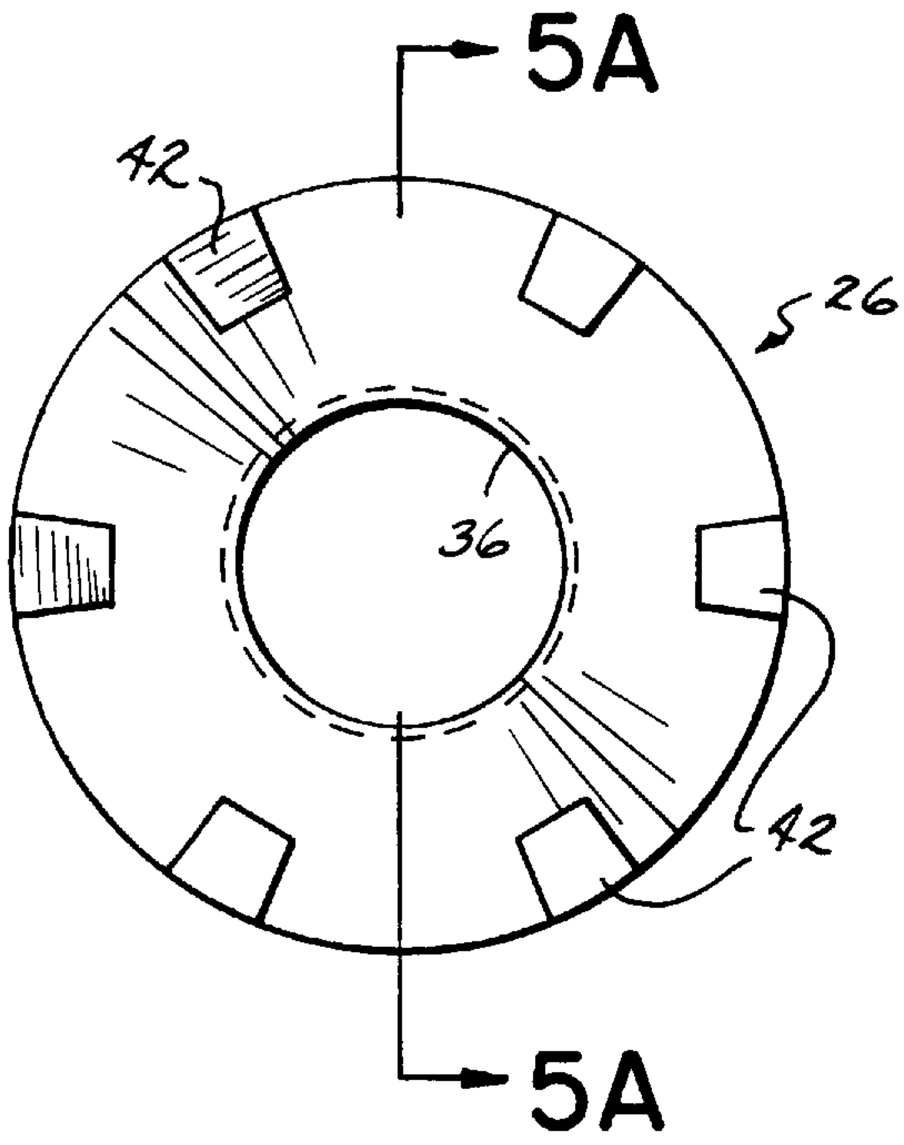


FIG. 5

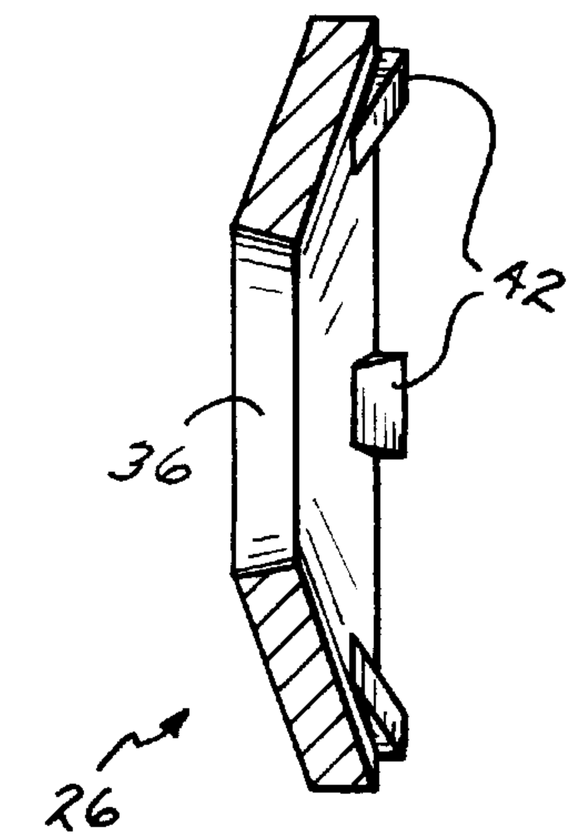


FIG. 5A

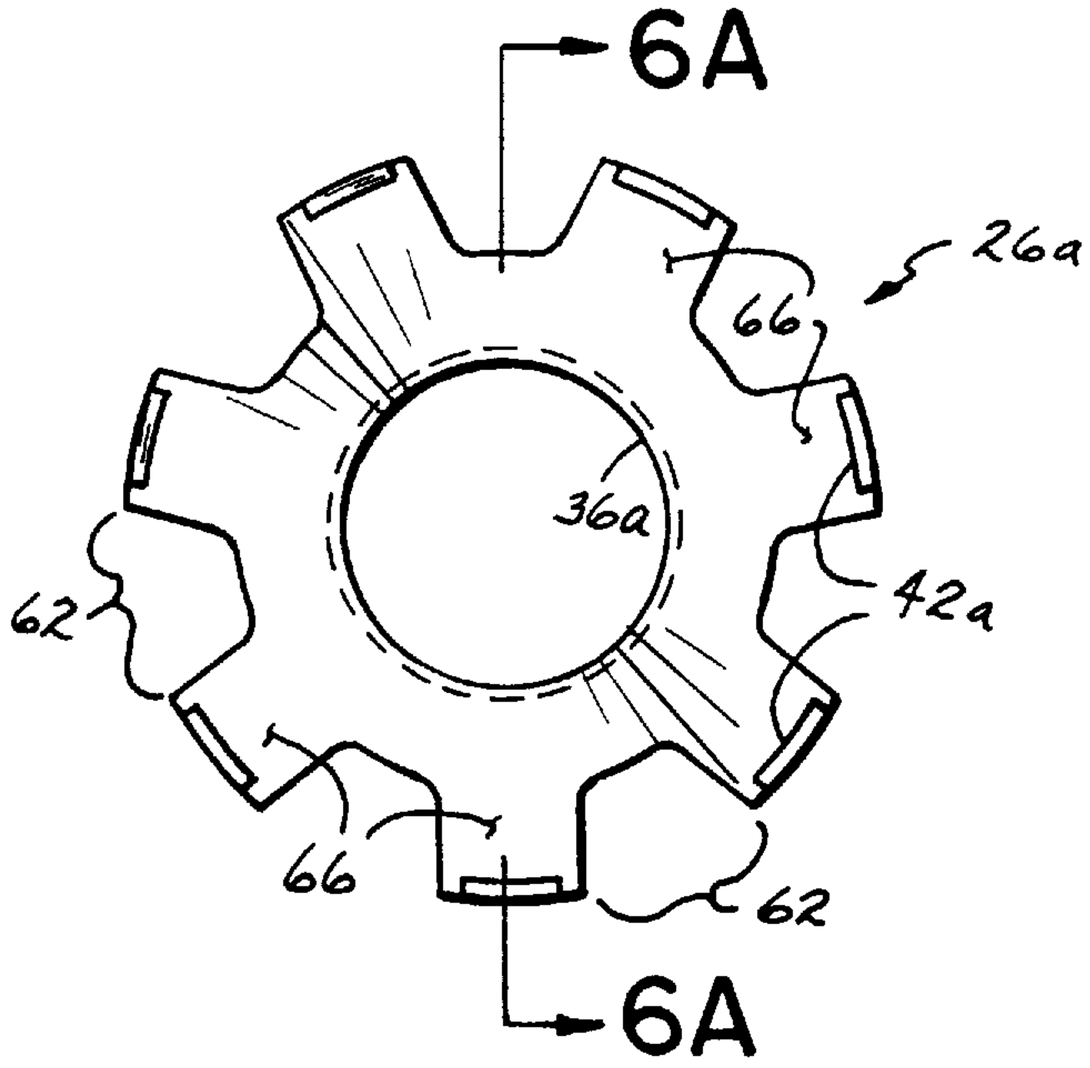


FIG. 6

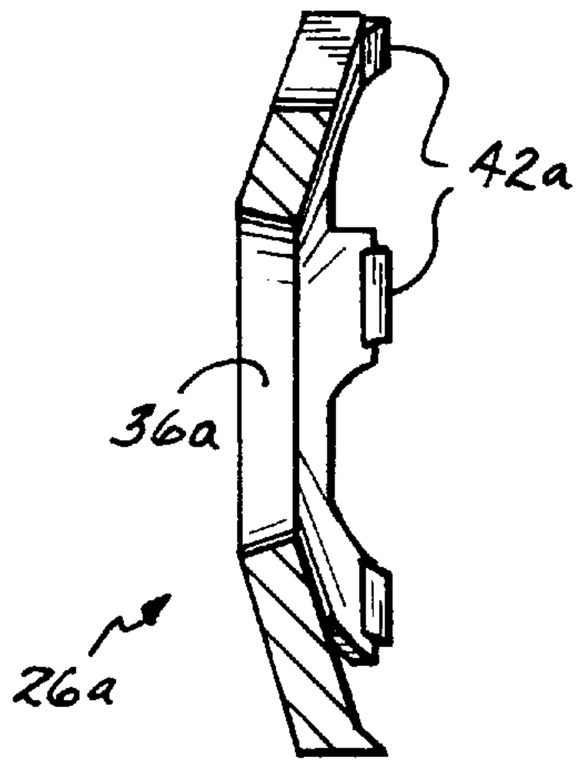


FIG. 6A

FASTENER ASSEMBLY FOR ESTABLISHING A MECHANICAL AND ELECTRICAL CONNECTION TO COATED METAL

BACKGROUND OF THE INVENTION

The present invention generally relates to fastener assemblies and, more specifically, to connections involving insulative coated metal that still allow for electrical conduction through the metal.

Two sheets of metal are often connected together with sheet metal screws or other types of fasteners in order to mechanically secure the two sheets together. Often it is desirous to electrically connect the two sheets of metal together to form an electrical pathway therebetween in order to electrically ground both sheets. Provided the sheets of metal are not painted and do not have some other insulation layer covering them, the metal-to-metal contact between the sheets and the fasteners connecting them will establish an electrical connection between the sheets. This facilitates the ability to ground the entire assembly.

When one or both sheets are coated with either a wet coat paint or a powder coat paint, the layer of paint covering the sheets often acts as an electrical insulator eliminating the electrical connection between the sheets. Therefore, either penetration of the coating or some other avoidance of the coating by the fastener assembly is required to maintain electrical conduction between the sheets and the fastener assembly. One may mask those areas of the sheet metal adjacent fastener holes before coating the sheet or scrape off the coating to facilitate metal to metal contact. These options, however, are time consuming and costly.

The preferred manner of establishing electrical conduction between a metal fastener assembly and a coated piece of metal has been to penetrate the coating with part of the fastener assembly during the assembly process. This penetration may be accomplished through the use of a washer adapted to penetrate through a layer of insulating material upon tightening of an associated fastener. If the fastener is a sheet metal screw, tightening the sheet metal screw causes the threads of the screw to contact the edges of a hole in one of the sheets of metal and projections on a washer to penetrate through the layer of insulation and contact the metal of the other sheet thereby creating an electrical pathway between the sheets. These washers may have a plurality of relatively sharp projections on one or both surfaces to penetrate through the paint or insulation layer of the sheet.

Some of the simplest forms of washers usable for the purpose of penetrating or coating have been conventional toothed spring washers, such as those sold by Shakeproof Corp. Such washers are concavely shaped and, upon tightening of the fastener assembly, the washer slightly compresses and the teeth scrape into the coating in an attempt to contact the underlying metal. However, penetration by the teeth completely through the coating to the underlying metal is often insufficient to establish grounding, especially with thicker paints such as powder coat paints. Also, upon removal of the fastener the washer springs back away from the sheet and tends to fall off. This makes disassembly and maintenance much more troublesome, especially when numerous fasteners must be removed during the process.

Another washer used in the past is referred to as an external tooth lock washer, also available from Shakeproof Corp. This washer is essentially flat but has peripheral teeth oriented downward to lock onto a surface upon tightening of a fastening assembly. These washers have only been partially successful in establishing an electrical connection with

coated metal. The main problem has been their inability to displace enough of the coating to achieve contact between the teeth and the underlying metal, especially when using powder coat paints. These washers also generally fall off during disassembly. That is, they fail to make an independent mechanical connection to the coated surface.

It would therefore be desirable to provide a fastener assembly and process utilizing a fastener and a toothed washer wherein the teeth of the washer consistently contact metal underlying even relatively thick coatings. It would also be desirable to provide such a washer that remains mechanically affixed to the coated piece of metal upon the removal of the fastener.

SUMMARY OF THE INVENTION

The present invention provides a fastener assembly for reliably establishing an electrical pathway between the fastener assembly and a coated piece of metal and, in addition, maintains a mechanical connection between the coated piece of metal and a washer associated with the fastener assembly upon removal of the fastener portion of the assembly. Specifically, the invention pertains to any electrically operated device which requires grounding during operation. In its broadest form, therefore, this device would comprise at least one piece of metal coated with an electrically insulative coating and a fastener assembly for establishing an electrical connection and, preferably, both a mechanical and electrical connection to the piece of metal.

The fastener assembly includes a fastener engageable with a piece of metal to establish a mechanical connection therewith and further includes at least one washer disposed between at least a portion of the fastener and the piece of metal. The washer includes a generally concave side and has a plurality of projections on the generally concave side. The washer is compressible between the fastener and the piece of metal. During this compression, the washer is permanently flattened and the projections are urged downwardly into the coating and in a radially outward direction. The ability of the washer to completely flatten during the assembly process significantly improves contact of the projections with the underlying piece of metal.

According to one aspect of the invention, a build-up of coating material forms on the projections such that, upon removal of the fastener, the washer remains flattened and mechanically connected against the piece of metal by the built up coating material. To maintain the flattened condition of the washer even after removal of the fastener, the washer is formed of a permanently deformable metal. The metal may be slightly hardened as long as the hardening does not interfere with the ability of the washer to be permanently flattened. For example, the projections of the washer may be hardened to improve the cutting action without significantly hardening the rest of the washer.

In one preferred embodiment, the fastener is a threaded fastener having a head portion that engages the convex side of the washer and pushes the washer flat against the piece of coated metal during tightening of the fastener assembly. The fastener may, for example, be either a sheet metal screw, a machine screw, or a bolt. In the case of a sheet metal screw attaching two coated pieces of sheet metal together, an electrical pathway is formed between the first piece of sheet metal and the second piece of sheet metal respectively through the washer, the head of the screw, and the threads of the screw which are in contact with the second piece of sheet metal. In the case of a machine screw or a bolt, a nut may be used to secure two pieces of metal together with a washer

of the present invention disposed between the head of the screw and the first piece of metal and another washer of the present invention disposed between the nut and the second piece of metal when the second piece of metal is also coated with an electrically insulative coating.

A method of the present invention includes inserting the fastener through a washer constructed generally as disclosed above with the generally concave side of the washer facing a coated side of the piece of metal. The fastener is then used to permanently flatten the washer against the piece of metal to cause the projections to penetrate the coating and contact the piece of metal underneath. In accordance with the advantages of this invention, the fastener is removed and the washer remains permanently flattened against the piece of metal and mechanically connected to the piece of metal by a build-up of coating formed on the projections.

From the above description, several objectives and advantages of this invention will be apparent. Among these, a fastener assembly constructed in accordance with this invention provides both a mechanical and electrical connection between the fastener assembly and one or more pieces of coated metal, such as sheet metal which has been painted using either a wet coat paint or a powder coat paint. Upon removal of the fastener, the permanently flattened washer or washers associated with the fastener assembly remain attached to the coated pieces of metal. This not only makes assembly and disassembly easier, such as during maintenance operations, but provides a visual indication of grounding. That is, if the washer is flattened against the piece of coated metal, a grounding pathway has been established.

These and other objectives and advantages of the present invention will be more readily understood upon review of the following detailed description of the preferred embodiments taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional view of the fastening assembly of the present invention utilizing a sheet metal screw as a fastener prior to assembly.

FIG. **2** is a cross-sectional view of the fastening assembly of FIG. **1** electrically and mechanically connecting two sheets of metal after assembly.

FIG. **2A** is a cross-sectional view of two coated sheets of metal having the washer of FIG. **5** embedded in the upper sheet after removal of the fastener.

FIG. **3** is a cross-sectional view prior to assembly of a fastener assembly comprising a machine screw, two washers and a nut.

FIG. **4** is across-sectional view of a fastening assembly of FIG. **3** after assembly.

FIG. **4A** is a cross-sectional view of two coated sheets of metal having the washers of FIG. **5** (from alternative embodiment in FIGS. **3** and **4**) embedded in the upper and lower sheets after removal of the fastener.

Fig. **5** is a bottom view of the washer of the fastening assembly.

FIG. **5A** is a cross-sectional view taken along the line **5A—5A** of FIG. **5**.

FIG. **6** is bottom view of an alternative embodiment of the washer of FIG. **5**.

FIG. **6A** is a cross-sectional view taken along the line **6A—6A** of FIG. **6**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, and particularly to FIG. **1**, there is illustrated the fastening assembly **10** of the present invention. The fastening assembly **10** is used to mechanically and electrically connect a first sheet of metal **12** having a coating or layer of insulating material **14** on top of the sheet and a coating or layer of insulating material **15** below the sheet and a second sheet of metal **16** beneath the first sheet **12**. The second sheet **16** is illustrated as having a coating **18** of insulating material below the second sheet and a coating **19** of insulating material on top of the second sheet. This layer of insulating material is most commonly a coating of paint but may be any other type of electrically insulating coating. However, the second sheet **16** need not be coated with an insulating material. The second sheet **16** has at least one hole **20** therein which is aligned with at least one hole **22** in the first sheet **12**, the hole **22** of the first sheet **12** being of greater diameter than the hole **20** in the second sheet.

In its simplest form the fastening assembly **10** comprises a fastener **24** and a washer **26** constructed in accordance with the invention. The fastener **24** may be any number of items including screws and bolts as long as the fastener is engageable with and capable of being tightened against the washer **26**. In the preferred embodiment, the fastener **24** has a head **28** at one end and a plurality of threads **30** on the other end of the fastener **24**. The heads **28** of the fasteners illustrated are shown having a cross **32** (see FIG. **2**) corresponding to and for the insertion of the end of a Phillips screwdriver in order to turn the fastener **24**. However, a cross is not necessary; a slot may alternatively be placed in the heads of the fasteners **24**. The fastener **24** illustrated in FIGS. **1** and **2** is a sheet metal screw having a conical body **34** which has wrapped around it a plurality of threads **30**. The washer **26** of the fastener assembly is generally concavely shaped and has a hole **36** therein, the hole **36** of the washer being aligned with the holes **22, 20** of the first and second sheets respectfully. The concavely shaped washer is placed on top of the aligned holes **20, 22** so the washer protrudes above the upper surface of the first sheet **12**.

In order to secure the sheets together, the fastener **24** is rotated and pushed downwardly with a screwdriver or other tool so that the fastener passes through the hole **36** in the washer, the hole **22** in the first sheet **12** and partially into the hole **20** of the second sheet **16**. The diameter of the hole **22** in the first or upper sheet **12** is greater than the diameter of the threads **30** of the fastener **24** so the fastener **24** may pass therethrough without any need to rotate the fastener **24**. The diameter of the hole **20** in the second sheet **16** is such that only part of the length of the screw body **34** may pass therethrough without rotating the head **28** of the fastener **24**. A screwdriver is then inserted into the cross **32** of the head **28** of the fastener **24** and rotated causing the threads **30** of the fastener **24** to cut into the metal of the second sheet **16** proximate the hole **20** in the second sheet **16**. The washer **26** is pushed downwardly between the lower edge **38** of the fastener head **28** and the upper surface **40** of the first sheet **12**. As the washer **26** is flattened a plurality of projections **42** around the periphery of the washer (see FIGS. **5, 5A**) are pushed generally downwardly and radially outward through the layer **14** of insulating material and against the metal of the first sheet **12**, establishing metal-to-metal contact between the projections **42** of the washer **26** and the metal of first sheet **12**.

As illustrated in FIG. **2**, a build-up of insulating material **44** forms over the outside of the projections **42** of the washer **26** due to the projections being pushed downwardly and outwardly upon the flattening of the washer **26**. The metal-to-metal contact between the projections **42** of the washer **26** and the metal of the first sheet **12** establishes an electrical

connection between the first sheet **12** and the washer **26**. Because the threads **30** of the fastener **24** contact the metal of the second sheet **16**, an electrical circuit is created from the second sheet **16** through the fastener **24** to the washer **26** and through the projections **42** of the washer **26** to the first sheet **12**. Through this circuit the second sheet **16** is electrically connected to the first sheet **12** and grounding of the sheets is possible.

FIG. **2**A illustrates the washer of the present invention upon removal of the fastener in FIG. **2**. The washer **26**, upon removal of the fastener **24** remains permanently flattened against the insulation **14** of the upper sheet of metal **12** due to the mechanical connection between the projections of the washer and the insulation layer **14** of the sheet metal. Because the washer **26** is made of a permanently deformable metal, the washer **26** does not spring back to its original form and separate from the sheets of metal upon the removal of the fastener **24**, but rather remains flattened once the fastener **24** is removed. This feature of the present invention allows one or more fasteners to be removed without the washers falling off the metal and being lost or displaced. Therefore, a user may remove the fasteners **24** in order to separate the two sheets **12, 16** of metal temporarily but then quickly and easily put the sheets **12, 16** of metal together the way they were without losing the washers **26**.

FIGS. **3** and **4** illustrate an alternative fastening assembly used to connect two sheets of metal together, one sheet being on top of the other. The primary difference between this fastening assembly and the fastening assembly of FIGS. **1** and **2** is that a machine screw is used as the fastener **48**. In addition, a second washer **56** and a nut **46** are utilized to hold the machine screw in place and the sheets **12***a*, **16***a* together. In place of a machine screw a bolt having threads on the lower end thereof may be used as part of this fastening assembly. Specifically, the fastening assembly **10***a* of this embodiment comprises a fastener **48** which may be a bolt or machine screw having a head **50** at one end and a plurality of threads **52** at the other end thereof. The threads **52** are adapted to receive a nut **46** which has hole therethrough (not shown) the hole having threads on the inner surface thereof. The fastening assembly **10***a* utilizes two washers **54, 56** of the same type described hereinabove rather than just one washer as used in the embodiment of FIGS. **1** and **2**. Both washers are concavely shaped, have a hole therein and have the plurality of projections around the edge thereof. The first of the two washers **54** is aligned with the hole **55** of the washer **54** over the top of the holes **20***a*, **22***a* in the two sheets, the washer **54** being between the head **50** of the fastener **48** and top insulating layer **14***a* of the upper sheet of metal **12***a*. The second washer **56** likewise has a hole **57** therein and is placed directly underneath the aligned holes **22***a*, **20***a* in the first and second sheets respectively.

In use, the fastener **48** is inserted through the hole **55** in the first washer **54**, through the aligned holes **22***a*, **20***a* in the sheets of metal and through the hole **57** in the second or bottom washer **56** while the washers are held in place. The nut **46** is then threaded onto the lower threaded portion **52** of the fastener **48** and the screw head or nut rotated relative to the other so that the upper washer is flattened between the lower surface **60** of the head **50** and the upper layer of insulation **14***a* of the first sheet **12***a* and the second washer **56** is flattened between the upper surface of the nut and the lower surface **64** of the second sheet **16***a*. Upon the tightening of the fastener **48** the washers **54, 56** flatten causing the projections of the washers to pass through the insulation layers **14***a*, **18***a* and establish a metal-to-metal contact between the projections of the washer and the metal interior of the sheets **12***a*, **16***a*. Therefore, even though the threads of the fastener do not dig into the metal as in the sheet metal screw of the first embodiment (FIGS. **1** and **2**) a metal-to-metal grounding contact is established between the sheets through the fastener and both washers.

FIG. **4**A illustrates two of the washers **54, 56** of the present invention upon removal of the fastener **48** in FIG. **4**. The washers, **54, 56** upon removal of the fastener **48** remain flattened against the insulation **14***a* and **18***a* of the upper and lower sheets of metal **12***a* and **16***a*, respectively. The washers **54, 56** both have the same mechanical characteristics as the washer **26** which was described earlier regarding FIGS. **1, 2**, and **2**A.

FIG. **5** illustrates a bottom plan view of the washer **26** of the present invention having a circular perimeter and a centrally located hole **36** therein. As best illustrated in FIG. **5**A, the washer has a plurality of projections **42** around the exterior thereof and is concavely shaped in cross-section. The projections **42** extend downwardly from the concave surface of the washer and although the washer itself is not of a hardened metal, the projections may be somewhat hardened in order to better penetrate the paint or insulation layer of the sheets of metal.

An alternative embodiment of the washer **26** is shown in FIGS. **6** and **6**A. This alternative washer **26***a* has portions of the washer removed along the perimeter of the washer. The periphery of the washer **26***a* of this alternative embodiment is not circular, but rather has an irregular shape. A plurality of areas **62** are cut out between extensions **66** of the washer. When compared to the washer of FIG. **5**, this alternative washer is made of less metal and therefore is cheaper to mass produce. As with the washer **26** of FIG. a plurality of projections **42***a* extend downwardly from the peripheral edge of the washer, the projections **42***a* being located at the periphery of the extensions **66**.

Those skilled in the art will appreciate changes and modifications which may be made without departing from the spirit of the invention. Therefore, we do not intend to be limited except by the scope of the following claims.

What claimed is:

1. An electrically operated device comprising at least one piece of metal coated with an electrically insulative coating and a fastening assembly for establishing both a mechanical and electrical connection to the piece of metal, said fastening assembly including:

a fastener engaged with the piece of metal to establish said mechanical connection therewith; and

a washer disposed between at least a portion of said fastener and the piece of metal, said washer having a generally concave side and having a plurality of projections on the generally concave side of said washer, said washer being compressible between said fastener and said piece of metal upon securement of said fastener with said piece of metal thereby causing the projections of said washer to be urged downwardly and move radially outward through said coating to make electrical contact with the piece of metal and form a buildup of coating material on said projections, said washer further being formed of a permanently deformable metal so that upon removal of said fastener said washer remains flattened and mechanically connected against said piece of metal by said build-up of coating material.

2. The device of claim **1** wherein the fastener is a threaded fastener having a head portion and said head portion engages a convex side of said washer during securement to said piece of metal.

3. The device of claim 2 further comprising an additional piece of metal secured with said fastener assembly, each piece comprising a sheet coated on at least one side with an electrically insulative coating and having first and second aligned holes for receiving said fastener.

4. The device of claim 3 wherein said fastener is a sheet metal screw, the first aligned hole being of a size suitable for firmly engaging threads on the screw and the second aligned hole being larger than said first aligned hole, said washer being disposed about said second aligned hole.

5. The device of claim 2 further comprising a second piece of metal secured to said one piece of metal with said fastener assembly and wherein said fastener assembly further includes a nut threadingly engaging said fastener and a second said washer disposed between said nut and the second piece of metal.

6. A fastener assembly for providing an electrical and mechanical connection with a piece of metal, the fastener assembly comprising:

a fastener engageable with the piece of metal to establish a mechanical connection therewith; and

a washer securable between at least a portion of said fastener and the piece of metal, said washer having a generally concave side and having a plurality of projections on the generally concave side, said washer being compressible between said fastener and said piece of metal upon securement of said fastener with said piece of metal thereby causing the projections of said washer to be urged downwardly and move radially outward through said coating to make electrical contact with the piece of metal, said washer further being formed of a permanently deformable metal so that tightening said fastener against said washer completely flattens said washer and urges the teeth completely through said coating.

7. The assembly of claim 6 wherein the fastener is a threaded fastener having a head portion and said head portion engages a convex side of said washer during securement to said piece of metal.

8. The assembly of claim 7 wherein said fastener is a sheet metal screw.

9. The device of claim 7 wherein said fastener assembly further includes a nut threadingly engaging said fastener and a second said washer for disposition between said nut and a second piece of metal.

10. A method of securing a washer to a piece of metal having an electrically insulative coating wherein said washer is formed of a permanently deformable material and includes a generally concave side with a plurality of projections, the method comprising the steps of:

inserting said fastener through said washer with the generally concave side of said washer facing the coating; and

permanently deforming said washer against said piece of metal with said fastener to cause said projections to penetrate the coating and contact the piece of metal.

11. The method of claim 10 further comprising the step of:

removing said fastener from said washer whereby said washer remains permanently deformed against said piece of metal and mechanically connected to said piece of metal by a build-up of said coating on said projections.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,828,008

DATED : October 27, 1998

INVENTOR(S) : Mark D. Lockwood et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the title page, in the Abstract:

At [57], lines 4 and 7, change "flattened" to --deformed--.

Column 3, line 49, change "across-sectional" to --a cross-sectional-.

Column 6, line 32, after "FIG." insert --5--.

Claim 6, column 7, line 21, change "a" to --said--.

Claim 9, column 8, line 1, change "device" to --assembly-- and delete "wherein said fastener assembly"; and line 2, change "includes" to --including--.

Signed and Sealed this

Twenty-third Day of March, 1999

Attest:

Q. TODD DICKINSON

Attesting Officer

Acting Commissioner of Patents and Trademarks